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MEASUREMENT OF THE SIDEREAL-DAILY VARIATION OF COSMIC RAY INTENSITY

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(Ob izmerenii zvezdno-sutochnoy variatsii intensivnsoti kosmicheskikh luchey)

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The problem of sidereal-daily variations has for a long time been the object of attention of numerous scientists who devoted it several dozens of reference works. A relatively detailed review of these works has been made in [1, 2], where the difficulties of experimental determination of sidereal-daily variations' amplitude and phase were revealed.

Basically the experimental difficulty consists in that their period differs little from that of solar-daily variations.

The solar-daily variation is dependent upon the energy of primary cosmic radiation. Its differential spectrum may be represented approximately in the form :

$$\frac{\delta D(\varepsilon)}{D(\varepsilon)} = \begin{cases} 0{,}14\,\varepsilon^{-1}, & \varepsilon > \varepsilon_1, \\ 0 & , \varepsilon < \varepsilon_1, \end{cases}$$

where $\varepsilon_1 \approx 6{,}6$ BeV.

For the extra-galactic cosmic ray flux the sidereal-daily variation does not depend on energy and is equal to 0.3% [3].

In this case, the expression for the primary radiation spectrum creating the sidereal-daily variation has the form :

$$\frac{\delta D(\varepsilon)}{D(\varepsilon)} = \text{const}.$$

The sidereal-daily variation related to cosmic rays of galactic origin must depend on cosmic ray energy (this is the more probable case), and its amplitude must increase as the energy rises [4] :

$$\frac{\delta D(\varepsilon)}{D(\varepsilon)} = a\varepsilon^{b},$$

where $b > 0$. Therefore, the amplitude of solar-daily variation drops as the energy increases, while that of the sidereal-daily variation increases and is independent from energy.

That is why the extra-atmospheric solar-daily variation may be reduced to a sufficiently small value for sufficiently great cosmic ray energies. The sidereal-daily variation was not searched for at random in high-energy particles, particularly in showers, whose energy is of the order of $10^{14} - 10^{18}$ eV [5–10]. But even at such high energies it is quite difficult to identify reliably the sidereal-daily variation, for there remains the solar-daily variation of atmospheric origin, whose amplitude and phase vary in the course of the year, which disallows the application of the Thompson method [11]. The accounting of meteorological effects for cosmic ray showers is at present quite difficult.

However this difficulty may be easily by-passed if one applies a method similar to that of crossed telescopes by Elliot and Dolbear [12]. To do that it is necessary to register simultaneously the oblique showers at a point of 45° geographic (N) latitude, originating from the southerly and northerly directions at a 45° angle to the vertical. Then the oblique showers originating from the north will bring information from a specifically fixed portion of the Galaxy as the Earth rotates, while the frequency of showers originating from the south will reflect the radiation anisotropy in the Galaxy plane. The atmospheric solar-daily variation will be identical for these showers, while the sidereal-daily variation will be significantly different, since for the oblique showers originating in the north the sidereal-daily variation must be absent. Then, the difference south-north will provide the proper value of the sidereal-daily variation. The oblique showers may be registered by the method of delayed coincidences, but this lag constitutes a quantity of the order of 10^{-6} sec.

With the use of spark counters, particularly of plastic scintillators, whose de-excitation time is of the order of 10^{-9} seconds, the registration of oblique showers became a reality.

Therefore, the new technique of cosmic ray registration at sea level with the aid of plastic scintillators provides the possibility of a reliable registration of the sidereal-daily variation of broad atmospheric showers. This will contribute substantially to the solution of the question of the origin of cosmic rays.

In conclusion, I express my gratitude to O. I. Inozemtseva and N. S. Kaminer for the discussion of the question raised.

***** E N D *****

I Z M I R A N *)

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